PIEneering

Parallel Image Engineering

RapidStation Block File Format

Version 1.0

THE GROUND TRUTH

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PIEneering Ltd
Hylkeenpyytäjänkatu 1
FIN-00150 Helsinki
FINLAND

Tel: +358 9 6219 0920
Fax: +358 9 6219 0921
mail to: swsupport@pieneering.fi
www.pieneering.fi

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Introduction

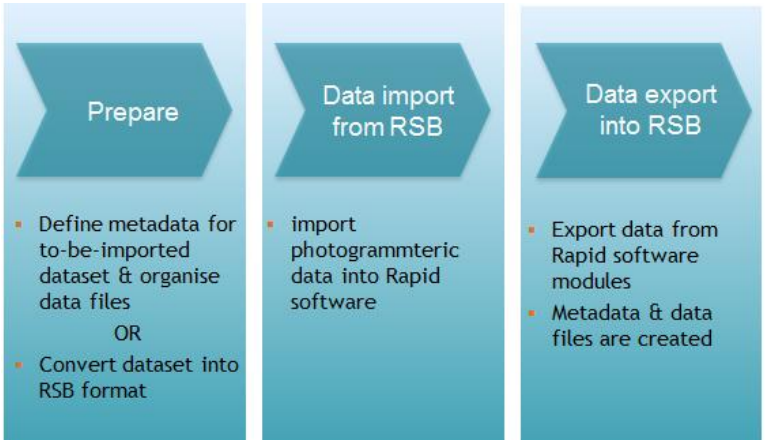
The purpose of the RapidStation Photogrammetric Image Block Data ASCII Format (RSB) of PIEneering is to offer an intuitive, human readable text file format in contrast to the binary *.clu file format used by Rapid* software to store and describe photogrammetric block data.

Another equally useful purpose is to make it easy to import various photogrammetric blocks in ASCII tabular and list format into Rapid* software without the need of a separate file format converter.

The principal method for preparing data for import is to define metadata, with RSB rules described in this manual, which explicitly describes the to-be-imported dataset. There are basically two options to choose from:

- create a RSB-file with metadata only pointing to the original data files, which are left intact containing the actual data.
- convert an external dataset into a one RSB-file containing all data

The contents of this manual may be found quite comprehensive due to very flexible and powerful nature of RSB format itself. However, the logic of the format can be quite easily adopted by studying the examples in chapter Example data.


Prepare
Define metadata for to-be-imported dataset & organise data files
OR
Convert dataset into RSB format
Data import from RSB
import photogrammteric data into Rapid software
Data export into RSB
Export data from Rapid software modules
Metadata & data files are created

Principal structure

Sections & keywords

In majority of cases where a third party photogrammetric software store data in some kind of tabular form it should be possible to import that data directly by writing metadata information into the RSB-file instead of converting the project files to PIEneering formats in a separate step. This way the RSB-file may remain constant in the event that for instance the orientation parameters are updated into the external file by the third party software.

Typically a photogrammetric block contains information about the imaging flights (image names and the order of the images), the initial positions of the images up in the air (trajectory data) eventually the final exterior-orientation parameters of the images. The blocks also often have information about the cameras used, ground control points and tie points, their ground coordinates (measured and adjusted) and image coordinates (measurements or observations). Then there also might be information about the initial accuracy values of all observations etc.

The RSB file format is a human readable ASCII file format which contains a number of sections similar to what can be found in, e.g., Windows INI-files. The sections, which can be in any order in the file all are all constructed in the following way:

- Each **section** starts with a header in brackets, e.g., “[exterior-orientation]”.
- After the section header certain **keywords** and their corresponding values can be listed, e.g., “mean-terrain-height= 50”. The keywords can be listed in any order and some of them are mandatory and others optional. The applicable values for each section and its keywords are described explicitly in this manual.
- After the keywords **tabular data** can be listed. This tabular data can optionally be read from external files.
- The section ends when the next section starts or the file ends.

There’s a mandatory section with fixed name in an RSB-file : **[rapidstation-block].** Moreover, section **[trajectory]** or section **[exterior-orientation]**, or both, are mandatory in an RSB-file. The remaining structure depends on the content of the file and can be mandatory or optional. If for example there is a keyword-value line “flights= 4 5” in section “[rapidstation-block]”, then three need to be sections “[flight-4]” and “[flight-5]” in the RSB-file.

The RSB-file may contain comments starting with hash (“#”). Whole lines can be comments or just the end of the line starting from “#”. If a comment needs

several lines all of them has to start with "#". In the import phase all comments are ignored as are all empty lines and lines with only spaces.

Example

```
# this is a comment line
[ground-control-points]                          # first defined section
coordinate-system=      FinnKKJ                  # this is a comment at end of line
units=                  metre
columns=                ID E N H WC              # the columns of the data below
1 378631.9105 6676426.4581 29.5690 xyz1  # this data could also be in an external file
2 378640.1249 6676575.7178 22.3300 xyz1
3 378924.3634 6676402.8376 23.1660 xyz1
5 379205.8186 6676452.0335 19.6590 xyz2

# empty lines are allowed

[trajectory]                                     # second defined section
coordinate-system=      WGS84
units=                  degree metre degree      # horizontal vertical attitude
columns=                FLIGHTLINE PHOTO LON LAT ALT HEAD DATETIME_ISO2 ROLL PITCH YAW
external-file=          flight1.log              # data as defined by "columns" is read from this file
```

External files

All data of a photogrammetric block besides the actual images can be stored in one RSB-file only but there can be a few reasons for using external files instead:

- keeping the metadata in the RSB-file separated from the data files
- keeping the RSB-file short and compact
- some data, such as ground control points measurements, can be common to many projects or blocks and can this way be stored in one common place only
- some data, such as exterior orientation parameters that might change often as new block adjustments are run, can be stored in some other file
- third party software are used to create the external files

External files are included into the RSB file during the project import in the software. External files are named with the keyword **external-file.**

During import some additional keywords can be used to enable reading of some specific portion of these files. These keywords are:

skip-lines = *number*

We might want to skip the first *number* of lines before starting to read. By default no lines are skipped.

Example:

```
skip-lines= 10
```

read-lines = *number*

With this tag we can define how many lines to read (after possibly skipped lines). By default all is read until the end of file.

start-tag = *text-string*

In case we do not in advance know how many lines to skip but there is some text string to start reading from in the file we can define it here. The tag or text string looked for, e.g., the string "# START" should be the first non-blank characters on the line. By default the reading starts form the beginning of the file.

Example:

```
start-tag= "# START FROM HERE"
```

end-tag = *text-string*

In case an external file is used we might want to stop reading at some point and skip the stuff at the end of the external file. The tag or text string looked for, e.g., the string "# END" should be the first non-blank characters on the line. By default the reading stops at the end of the file.

comment-symbols = *symbols*

In case the external file has comments preceded with some symbol it can be defined here. The default comment symbol is the hash sign (#) so it does not have to be mentioned but if it is mentioned it has to be written inside quotes ("#") as it otherwise is interpreted as a comment in the RSB-file. If many comment symbols are defined, e.g., "#%;:", then they all individually are treated as comment symbols.

Example:

```
comment-symbols= "%#"
```

column-delimiter = *symbol*

By default the column delimiter is space, a blank character, but if it is something else it can be defined here. Multiple consecutive unquoted spaces and/or tabs are treated as one space character when splitting data into columns.

Example: column-delimiter= ";"

decimal-symbol = *symbol*

By default the decimal symbol of floating point numbers is period (.), but if it is comma or something else it can be defined here.

Example:

```
decimal-symbol= ","
```

Sections

On the following pages all supported sections with corresponding keywords and values are being described. The mandatory keywords of the sections are denoted with an asterisk (*). Optional values of keywords are within brackets.

[rapidstation-block] *

In the section [rapidstation-block] the following keywords are possible**:**

file-format-version = *number* *
The current RSB file format version number is 1. If file-format-version is other than 1 the file is illegal.

created = *date-and-time*
The date of the creation of the block is currently just for information.

modified = *date-and-time*
The date of the last modification creation of the block is currently just for information.

block-name = *name*
The name of the block is currently just for information.

coordinate-system = *horizontal [vertical]**
Currently only the horizontal coordinate system is used and thus the vertical part can be left out. The coordinate system must be defined as "LOCAL" or defined in PIEneering's coordinate system database **csystems.ini** , for example "WGS84-UTM/SUTM33". See separate documentation of csystems.ini. In this section the coordinate system of the **output** files is being defined. A coordinate system for the input data, i.e. the coordinate system for the ground control points, can be defined separately in a corresponding section. A coordinate system defined as "LOCAL" means that the block is a close range photogrammetry block, perhaps indoor one. When "LOCAL" is used then X/Y/Z should be used in the rest of the file (instead of E/N/H or LON/LAT/ALT).
Example:
```
coordinate-system= WGS84-UTM/SUTM33
```

units = *object-unit [angular-unit [image-unit]]*
The units (object, angular, image) can be units defined by the European Petroleum Survey Group (EPSG), listed in Appendix 1. The default values of the three units are: metre, degree and rawpixel. The units defined here will be used for all output and are by default used also for all input, unless defined otherwise in the corresponding input sections.
Example:
```
units= usfoot gon
```

flights = *name1 [name2 [name3…]]]**

These are the names of the flights of the block. One flight consists of all images acquired between take-off and landing of a manned or unmanned aircraft. For each flight all environmental (weather, date) and imaging parameters (camera, its settings and its orientation in the aircraft) are constant. For each flight listed here a corresponding section flight-*name* must be found in the RSB-file (see below).

[flight-*name*]*

The name of this section depends on keyword **flights** in the section **[rapidstation-block].** If the keyword line is "flights= 6 7" then the corresponding section names would be [flight-6] and [flight-7]. The following keywords are possible in this section**:**

units = *mean-terrain-height-unit*

If the unit of "mean-terrain-height" below is other than what is specified by the *object-unit* of keyword "units" in section [rapidstation-block] (or metres if *object-unit* was not specified), the correct unit should be specified with "units" keyword.

mean-terrain-height = *height-value**

This is the approximate average height above sea level of the terrain covered by the current flight. In the case of UAVs if can be the GPS elevation of the start or landing point, which normally can be found in the log files.

image-paths = *image-folder**

The location of all images of a flight is specified with this keyword. It can be absolute or relative to the folder of the RSB file.

Example:

```
image-paths= "..\..\images 1"
```

(note double quotation marks because of blank characters in the file name).

platform = *name**

The UAV platform used during a flight (e.g. " uav1"), requires a section [platform-uav1] containing camera information in the RSB-file.

image-deformation-set= *name*

If self-calibration of the camera was done with RapidStation bundle block adjustment in order to account for changes in the camera since the last full calibration the link to parameters are given here. The actual parameters should then be found in section [image-deformation-set-*name*].

external-file= *name*

If the image file names etc. are listed in one or more external text files instead of in tabular form at the end of this section then the external files should be listed here.

columns= *description-of-the-columns*

"columns" keyword describes the contents of the tabular data *either* at the end of this section *or* in an external file. The tags should be listed in the same order as they appear. The allowed column tags are:

- **O_EXCLUDE**: optional asterisk (*) in the corresponding columns of the line of the image tells that the image of the current line is to be excluded from the processing. If the asterisk is not present in that column the image is to be processed normally. If this tag is first on the image line it is easy to "comment out" images with a text editor.
- **FLIGHTLINE**: the number of the light lines containing the current image. Normally the flight line number changes when the aircraft turns back and flies the next flight line of the block.
- **PHOTO**: the number of the image or frame within the flight line. This number can start from 1 at the beginning of each flight line but it can also be a sequential numbering for all images in the block.
- **FLIGHTLINEPHOTO**: another way of expressing the flight line and photo number in one word of type LXXXFYYYY where XXX is the flight line number and YYYY the photo number. Either FLIGHTLINE & PHOTO or FLIGHTLINEPHOTO should be used, not both.
- **IMAGEFILE**: the name of the image file. The folder name given by image-paths will be added in front of the image file name to create a relative path to the images from the current folder.
- **O_ATTRIBUTES**: optional attributes describing the images. Allowed attributes are:
  - **blurred**: the image is more shaken, out of focus or blurred than most of the other images. This attribute tells that the image can be used in aerial triangulation but it should not be used in mosaics.
  - **water**: the image contains only moving water or something similar which inhibits it from being used in aerial triangulation but it should still be used in the mosaics with the help of approximate exterior orientation parameters given, for example in the [trajectory] section.
- **SKIP**: this column is to be skipped and ignored

Example:

```
columns= O_EXCLUDE FLIGHTLINE PHOTO IMAGEFILE O_ATTRIBUTES
*  1 1 ima1.jpg
   1 2 ima2.jpg blurred
   1 3 ima3.jpg
   1 4 ima4.jpg
   2 1 ima5.jpg water
```

[platform-*name*] *

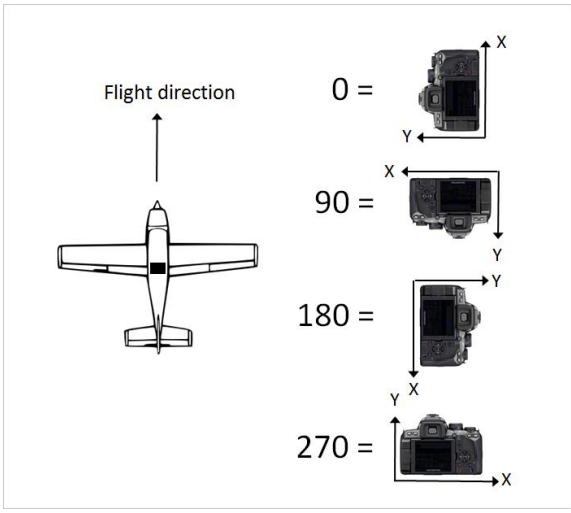
The name of this section depends on keyword **platform** in section **[flight-*name*].** If the keyword line is "platform= my-uav" then the corresponding section name would be [platform-my-uav]. The following keywords are possible in this section:

cameras = *camera-name**

Currently only one camera per platform is supported but later on there could be more cameras. If the name given is “cam1” then there should be a section named [camera-cam1] containing the calibration parameters of the camera.

camera-rotation = *rotation-angle*

Camera rotation in degrees as shown in picture below.



Camera rotation in relation with flight direction.

antenna-offset = *dx dy dz*

The location of the GPS antenna relative to the camera defined in metres. Default values are 0 0 0.

boresight-misalignment = *dOmega dPhi dKappa*

The rotation angles between the camera and IMU defined in degrees. Default values are 0 0 0.

use-raw-calibration = *yes/no*

If the camera calibration file contains parameters both for raw and normal (jpeg) modes this keyword is used to tell which one to use. Default: no

use-channels = *number*

If the camera calibration file contains parameters for more than one channels this keyword is used to tell which one to use. Default: default value is 3 (meaning green channel in case of 3 channels). If a number is written is must be listed with keyword **channels** in section [camera-*name*].

[camera-*name*] *

The name of this section depends on keyword **cameras** in section **[platform-*name*].** If the keyword line is “cameras= my-cam” then the corresponding

section name would be [camera-my-cam]. In this section *either* external-file *or* keywords below should be used, not both. More information of the calibration parameters can be found in the PIEneering's RapidCal Users Guide. The following keywords are allowed in this section:

external-file = *name*
Either an external file is to be used or keywords below should be used. This instance of external file is an exception to the general usage of external files, as this external file does not contain tabular data. Instead the file should be in format generated by RapidCal camera calibration software.

calibrated = *date-and-time*
Date and time when the calibration was performed.

camera-body = *name*
The name of the camera body, preferably listed in **cameramodels.ini** database of PIEneering's RapidCal camera calibration software.

lens = *name*
The name of the lens camera normally listed in cameramodels.ini of RapidCal camera calibration software.

owner = *name*
The name of the owner of the camera is here just for the information only.

trigger-delay = *seconds*
The default value of trigger-delay is 0s.

equation-set = *year*
The default value of equation-set is 2010. Prior to that year RapidCal used a different set of equations.

channels = number1 [number2 [number3 …]]*
Listing of the image channel numbers of the camera that was calibrated. Normally "1" for normal calibration and "1 2 3" for three channel calibration with RapidCal. For each channel a corresponding section [camera-*name*-channel-*number*] must be defined.

[camera-*name*-channel-*number*]*

Note

The section is optional if the corresponding data is being introduced in an external file.

The name of this section depends on keyword **cameras** in section **[platform-*name*]** and on keyword **channels** in **[camera-*name*].** If the first keyword line is "cameras= my-cam" and the second is "channels= 1" then the corresponding section name is [camera-my-cam-channel-1]. The following keywords are possible in this section:

sensor-width-pix-mm = *integer-number float-number [integer]**

Here the width of the imaging (CCD/CMOS) sensor are defined both in the number of pixels and in millimetres. If a third number is specified it relates to the size difference in pixels between jpeg and raw images in the case where the geometry of the image is not altered in other ways, meaning that no lens corrections are made in the camera when the jpeg image was created.

sensor-height-pix-mm = *integer-number float-number [integer]**

Here the height of the imaging (CCD/CMOS) sensor are defined both in the number of pixels and in millimetres. If a third number is specified it relates to the size difference in pixels between jpeg and raw images in the case where the geometry of the image is not altered in other ways, meaning that no lens corrections are made in the camera while the jpeg image was created.

focal-length-mm = *float-number*

The focal length of the camera is defined here in millimetres. Either this keyword or keyword **focal-length-pix** should be used. Note that real millimetres are used and not 35mm (full frame) equivalent millimetres.

focal-length-pix = *float-number*

The focal length of the camera is defined here in pixels. Either this keyword or keyword **focal-length-mm** should be used.

general-scaling = *float-number*

In the current equations used in Rapid software this value is always 0.01. It is also the default value and therefore the keyword may be omitted.

principal-point-col-pix= *float-number [integer-number]*

The x-coordinate (column-coordinate) of the principal point has its origin in the centre of the top left pixel of the image. The default value is calculated with formula (sensor-width-pix - 1)/2 and is being used with non-calibrated cameras. If a third number is specified it relates to the position difference in pixels between jpeg and raw images in the case where the geometry of the image is not altered in other ways, meaning that no lens corrections are made in the camera when the jpeg image was created.

principal-point-row-pix= *float-number [integer-number]*

The y-coordinate (row-coordinate) of the principal point has its origin in the centre of the top left pixel of the image. The default value is calculated with formula (sensor-height-pix - 1)/2 and is being used with non-calibrated cameras. If a third number is specified it relates to the position difference in pixels between jpeg and raw images in the case where the geometry of the image is not altered in other ways, meaning that no lens corrections are made in the camera when the jpeg image was created.

principal-point-x-mm= *float-number [integer-number]*

The x-coordinate (column-coordinate) of the principal point has its origin in the centre of the image. The default value is 0. Either this keyword or keyword **principal-point-col-pix** can be used.

principal-point-y-mm= *float-number [integer-number]*

The y-coordinate (row-coordinate) of the principal point has its origin in the centre of the image. The default value is 0. The Y-axis grows upwards. Either this keyword or keyword **principal-point-row-pix** can be used.

affinity = *float-number*
Affinity of the image calculated with formula Affinity = 1 - 1 / (aspect-ratio). The default value is 0.

radial-k1 = *float-number*
This is the 1st radial distortion parameter of the lens. The default value is 0.

radial-k2 = *float-number*
This is the 2nd radial distortion parameter of the lens. The default value is 0.

radial-k3 = *float-number*
This is the 3rd radial distortion parameter of the lens. The default value is 0.

tangential-t1 = *float-number*
This is the 1st tangential distortion parameter of the lens. The default value is 0.

tangential-t2 = *float-number*
This is the 2nd tangential distortion parameter of the lens. The default value is 0.

un-orthogonality = *float-number*
This is the deviation from a straight angle between the x- and y-axes of the sensor. The default value is 0.

[image-deformation-set-*name*]

The name of this section depends on keyword **image-deformatiohn-set** in section **[flight-*name*]**. If self-calibration of the camera was done with RapidStation bundle block adjustment in order to account for changes in the camera since the last full calibration the self-calibration model and its parameters are given here.

[trajectory]*

The values in this section are normally originated from the flight trajectory logs and are considered as initial approximate values for aerial triangulation. The more accurate values are stored under section **[exterior-orientation].** In case of a close-range photogrammetric block this section will refer to **X**, **Y** and **Z** co-ordinates, otherwise **E**(asting), **N**(orthing) and **H**(eight) or **LON**(gitude), **LAT**(itude) and **ALT**(itude) are being used. The following keywords are possible in this section:

coordinate-system = *horizontal [vertical]*
Currently only the horizontal coordinate system is used and thus the vertical part can be left out. Normally geographical coordinates of WGS84 system are being used. The coordinate system must defined in PIEneering's coordinate system database

csystems.ini. See separate manual describing csystems.ini. In this section the coordinate system of the trajectoy data is being defined. If case of close range photogrammetric block the coordinate system should be defined in section **[rapidstation-block]** and should not be defined in this section again.
Example:
```
coordinate-system= WGS84
```

units = *horizontal-unit [vertical-unit [attitude-unit]]*

The units (horizontal, vertical, attitude) are defined by the European Petroleum Survey Group (EPSG) and listed in Appendix 1. The attitude-unit is needed for IMU readings. The default values of the three units are: degree, metre and degree.
Example:
```
units= degree metre degree
```

common-position-weight-class= *class-id*

The position observations should have an a-priori accuracy or standard deviation. The values can be defined in section [position-weight-classes]. A specific weight class can be assigned to each trajectory data entry (with POSWC tag in **columns**). An alternative way is set a common value with keyword **common-position-weight-class**.
Example:
```
common-position-weight-class= pos1
```

common-attitude-weight-class = *class-id*

The attitude observations should have an a-priori accuracy or standard deviation. The values are defined in [attitude-weight-classes A specific weight class can be assigned to each trajectory data entry (with ATTWC in **columns**). An alternative way is set a common value with keyword **common-attitude-weight-class.**
Example:
```
common-attitude-weight-class= 1
```

external-file = *name*

If the trajectory data is in external files the external files should be listed here.

altitudes-from-ground-level *= yes/no*

If the altitudes listed in the tabular data are measured from ground level the value of this keyword should be set to yes. By default the altitudes are from sea level.

meridian-convergence-corrected *= yes/no*

If YAW is used in **columns** and it has been pre-corrected for meridian convergence the value of this keyword should be set to yes. The default value is no.

read-from-exif = *tag1 [tag2 [tag3...]]*

Instead of listing everything in the tabular data some information can be read from the exif headers of the images. Keep in mind that reading from exif-headers is slow. Also check that the data to be read really can be found and is reliable. The following values are allowed:

- **DATETIME**: date and time of image creation are read from the image.
- **GPSDATETIME**: the timestamp given by the GPS connected to the camera is read from the image.

- **GPSPOS**: latitude and longitude of the image are read from the exif header.
- **GPSHEAD**: GPS heading (direction of flight) is read from the exif header of the image.

Example:
```
read-from-exif= GPSDATETIME GPSPOS GPSHEAD
```

columns = *description-of-the-columns*

"columns" keyword describes the contents of the tabular data *either* at the end of this section *or* in an external file. The tags should be listed in the same order they appear. Use *either* triplet X/Y/Z, E/N/H *or* LAT/LON/ALT. X,Y,Z is used in close range photogrammetry only. None of the triplet tags should be used if read-from-exif= GPSPOS is used. Use *either* triplet OMEGA/PHI/KAPPA or ROLL/PITCH/YAW. Only one of the alternative LAT*, LON* and DATETIME* -tags should be used. The allowed column tags are:

- **FLIGHTLINE**: the number of the flight line or flight line set for an image. Normally the flight line number changes when the aircraft turns back and flies the next flight line of the block.
- **PHOTO**: the number of the image or frame within the flight line. This number can, e.g., start from 1 at the beginning of each flight line but it can also be a sequential numbering for all images in the block.
- **FLIGHTLINEPHOTO**: another way of expressing the flight line and photo number in one word of type LXXXFYYYY where XXX is the flight line number and YYYY the photo number. Either FLIGHTLINE & PHOTO or FLIGHTLINEPHOTO should be used, not both.
- **LON**: longitude of the point of image exposure.
- **LON2**: longitude of the point of image exposure so that two consecutive words are used for it, e.g. "12 43.122" in the meaning of degrees and minutes
- **LON3**: longitude of the point of image exposure so that three consecutive words are used for it, e.g. "12 43 23.122" in the meaning of degrees, minutes and seconds
- **LON4**: longitude of the point of image exposure so that four consecutive words are used for it, e.g. "12 43 23.122 W" in the meaning of degrees, minutes, seconds and east/west of Greenwich
- **LAT**: latitude of the point of image exposure
- **LAT2**: latitude of the point of image exposure so that two consecutive words are used for it, e.g. "12 43.122" in the meaning of degrees and minutes
- **LAT3**: latitude of the point of image exposure so that three consecutive words are used for it, e.g. "12 43 23.122" in the meaning of degrees, minutes and seconds
- **LON4**: latitude of the point of image exposure so that four consecutive words are used for it, e.g. "12 43 23.122 S" in the meaning of degrees, minutes, seconds and hemisphere
- **ALT**: altitude of the point of image exposure
- **E** : easting of the point of image exposure
- **N** : northing of the point of image exposure
- **H** : height of the point of image exposure

- **X** : X-coordinate of the point of image exposure
- **Y** : Y-coordinate of the point of image exposure
- **Z** : Z-coordinate of the point of image exposure
- **HEAD**: GPS heading at the point of image exposure
- **DATETIME_ISO**: Date and time in ISO8601 format: 2012-08-09T01:24:52.4 or with time zone 2012-08-09T01:24:52.4Z
- **DATETIME_ISO2**: Date and time in ISO8601 format with space: 2012-08-09 01:24:52.4 or 2012-08-09 01:24:52.4Z
- **DATETIME_UNIX4**: Date and time in UNIX format: Aug 09 01:24:52.4 2012
- **DATETIME_UNIX5**: Date and time in UNIX format: Thu Aug 09 01:24:52.4 2012 or alternatively Aug 09 01:24:52.4 GMT 2012
- **DATETIME_UNIX6**: Date and time in UNIX format: Thu Aug 09 01:24:52.4 GMT 2012
- **OMEGA**: omega rotation angle about the Z-axis according to ISPRS standard
- **PHI**: phi rotation angle about the Y-axis according to ISPRS standard
- **KAPPA**: kappa rotation angle about the Z-axis according to ISPRS standard. If the x-axis (col-axis) of the image aligns with the X-axis (east) of the ground coordinate system the angle is zero degrees. Grows counter clockwise when seen from above.
- **YAW**: yaw or heading is the rotation angle about the Z-axis obtained an IMU or INS device. When the nose of the aircraft points north the angle is zero degrees. Grows clockwise when seen from above.
- **PITCH**: pitch rotation angle about the lateral X-axis obtained an IMU or INS device. When the nose of the aircraft points straight ahead the angle is zero degrees. Positive pitch means nose up.
- **ROLL**: roll or bank rotation angle about the longitudinal Y-axis obtained an IMU or INS device. When the wings of the aircraft are levelled angle is zero degrees. Positive roll means left wing up.
- **POSWC**: weight class ID for position. The corresponding standard deviations are defined in [position-weight-classes]
- **ATTWC**: weight class ID for attitude. The corresponding standard deviations are defined in [attitude-weight-classes]
- **SKIP**: this column is to be skipped and ignored

Example:

```
columns= FLIGHTLINE PHOTO LON LAT ALT HEAD DATETIME_ISO2 OMEGA PHI KAPPA
```

[position-weight-classes]*

The values in this section are normally estimations on how accurate the GPS measurements on board the aircraft are or how well the values are synchronized with the images. The following keywords are possible in this section:

units = *object-unit*

The units are defined by the European Petroleum Survey Group (EPSG) and listed in Appendix 1, and they relate to the output object coordinate system defined in section [rapidstation-block]. The default value is metre.

columns = *description-of-the-columns*

"columns" keyword describes the contents of the tabular data *either* at the end of this section *or* in an external file. The tags should be listed in the same order they appear. The allowed column tags are:

- **ID**: unique string or number identification of the weight class.
- **S_E**: standard deviation of the easting coordinates.
- **S_N**: standard deviation of the northing coordinates.
- **S_EN**: standard deviation of the easting and northing coordinates.
- **S_H**: standard deviation of the height coordinates.
- **S_X**: standard deviation of the X coordinates.
- **S_Y**: standard deviation of the Y coordinates.
- **S_XY**: standard deviation of the X and Y coordinates.
- **S_Z**: standard deviation of the Z coordinates.
- **SKIP**: this column is to be skipped and ignored

Example:

```
columns= ID S_E S_N S_H
pos1 0.03 0.04 0.2
```

[attitude-weight-classes]*

Note

The section is mandatory, if the **column** keyword in section **[trajectory]** contains tag triplets **PHI, KAPPA, OMEGA** or **ROLL,PITCH, YAW**

The values in this section are normally estimations on how good the IMU/INS is or how good the values are synchronized with the images. The following keywords are possible in this section:

units = *object-unit*

The units can be any one of the units defined by the European Petroleum Survey Group (EPSG) and listed in Appendix 1, and they relate to the output angular coordinate system defined in [rapidstation-block]. The default value is degrees.

columns = *description-of-the-columns*

"columns" keyword describes the contents of the tabular data *either* at the end of this section *or* in an external file. The tags should be listed in the same order they appear. The allowed column tags are:

- **ID**: unique string or number identification of the weight class.
- **S_OMEGA**: standard deviation of the omega rotation angle.
- **S_PHI**: standard deviation of the phi rotation angle.
- **S_KAPPA**: standard deviation of the kappa rotation angle.
- **S_ROLL**: standard deviation of the roll rotation angle.
- **S_PITCH**: standard deviation of the pitch rotation angle.
- **S_YAW**: standard deviation of the yaw rotation angle.

- **SKIP**: this column is to be skipped and ignored

Example:

```
columns= ID S_ROLL S_PITCH S_YAW
att1 5 5 50
```

[exterior-orientation] *

Note

The section is mandatory when data-to-be-imported data will be processed with RapidTerrain

The values in this section are normally coming from the bundle block adjustment and are therefore normally more accurate than the values in section [trajectory]. In case of a close-range photogrammetric block this section will refer to X Y and Z co-ordinates, else E(asting), N(orthing) and H(eight) are being used. The following keywords are possible in this section:

coordinate-system = horizontal [vertical]*

Currently only the horizontal coordinate system is used and thus the vertical part can be left out. The value should be the same as corresponding value in section [rapidstation-block] referring to bundle block adjustment. The coordinate system must be one of the ones defined in csystems.ini. See separate manual describing csystems.ini.

units = object-unit [angular-unit]

The object-unit and angular-unit can be any one of the metric units defined by the European Petroleum Survey Group (EPSG) and listed in Appendix 1. The default values of the units are: metre and degree.

Example:

```
units= usfoot gon
```

columns = description-of-the-columns

"columns" keyword describes the contents of the tabular data *either* at the end of this section *or* in an external file. The tags should be listed in the same order they appear Use *either* triplet X/Y/Z, E/N/H *or* LAT/LON/ALT. X,Y,Z is used in close range photogrammetry only. The allowed column tags are:

FLIGHTLINE: the number of the flight line or flight line containing the current image. Normally the flight line number changes when the aircraft turns back and flies the next flight line of the block.

PHOTO: the number of the image or frame within the flight line. This number can, e.g., start from 1 at the beginning of each flight line but it can also be a sequential numbering for all images in the block.

FLIGHTLINEPHOTO: another way of expressing the flight line and photo number in one word of type LXXXFYYYY where XXX is the flight line number and YYYY the photo number. Either FLIGHTLINE & PHOTO or FLIGHTLINEPHOTO should be used, not both.

- **E**: easting of the point of image exposure
- **N**: northing of the point of image exposure
- **H**: height of the point of image exposure
- **X**: X-coordinate of the point of image exposure
- **Y**: Y-coordinate of the point of image exposure
- **Z**: Z-coordinate of the point of image exposure
- **OMEGA**: omega rotation angle about the Z-axis according to ISPRS standard
- **PHI**: phi rotation angle about the Y-axis according to ISPRS standard
- **KAPPA**: kappa rotation angle about the Z-axis according to ISPRS standard. If the x-axis (col-axis) of the image aligns with the X-axis (east) of the ground coordinate system the angle is zero degrees. Grows counter clockwise when seen from above.
- **SKIP**: this column is to be skipped and ignored

Example:
```
columns= FLIGHTLINE PHOTO E N H OMEGA PHI KAPPA
```

[ground-control-points]

The values in this section are normally coming from GPS or total station measurements on the ground and are normally quite accurate. In case of a close-range photogrammetric block this section will refer to X Y and Z co-ordinates, else E(asting), N(orthing) and H(eight) or LON(gitude), LAT(itude) and ALT(itude) are being used. The following keywords are possible in this section:

coordinate-system = *horizontal [vertical]**

Currently only the horizontal coordinate system is used and thus the vertical part can be left out. The value should be the same as corresponding value in section [rapidstation-block] referring to bundle block adjustment. The coordinate system must be one of the ones defined in csystems.ini. See separate manual describing csystems.ini.

units = *horizontal-unit [vertical-unit]*

The units can be any one of the units defined by the European Petroleum Survey Group (EPSG) and listed in Appendix 1. The attitude-unit is needed for IMU readings. The default values of the three units are: metre and metre.

Example:
```
units= degree metre
```

common-weight-class= *class-id*

The position observations should have an a-priori accuracy or standard deviation. The values can be defined in section [gcp-weight-classes]. A specific weight class can be assigned to each trajectory data entry (with WC tag in **columns**). An alternative

way is set a common value with keyword **common-weight-class**.
Example:
`common-weight-class= pos1`

columns = *description-of-the-columns*

"columns" keyword describes the contents of the tabular data *either* at the end of this section *or* in an external file. The tags should be listed in the same order they appear. Use *either* triplet X/Y/Z, E/N/H *or* LAT/LON/ALT. X,Y,Z is used in close range photogrammetry only. The allowed column tags are:

- **ID**: unique string or number identification of the ground control point.
- **E**: easting of the point
- **N**: northing of the point
- **H**: height of the point
- **X**: X-coordinate of the point
- **Y**: Y-coordinate of the point
- **Z**: Z-coordinate of the point
- **LON**: longitude of the point
- **LON2**: longitude of the point so that two consecutive words are used for it, e.g. "12 43.122" in the meaning of degrees and minutes
- **LON3**: longitude of the point so that three consecutive words are used for it, e.g. "12 43 23.122" in the meaning of degrees, minutes and seconds
- **LON4**: longitude of the point so that four consecutive words are used for it, e.g. "12 43 23.122 W" in the meaning of degrees, minutes, seconds and east/west of Greenwich
- **LAT**: latitude of the point
- **LAT2**: latitude of the point so that two consecutive words are used for it, e.g. "12 43.122" in the meaning of degrees and minutes
- **LAT3**: latitude of the point so that three consecutive words are used for it, e.g. "12 43 23.122" in the meaning of degrees, minutes and seconds
- **LON4**: latitude of the point so that four consecutive words are used for it, e.g. "12 43 23.122 S" in the meaning of degrees, minutes, seconds and hemisphere
- **ALT**: altitude of the point
- **OMEGA**: omega rotation angle about the Z-axis according to ISPRS standard
- **PHI**: phi rotation angle about the Y-axis according to ISPRS standard
- **KAPPA**: kappa rotation angle about the Z-axis according to ISPRS standard. If the x-axis (col-axis) of the image aligns with the X-axis (east) of the ground coordinate system the angle is zero degrees. Grows counter clockwise when seen from above.
- **WC**: weight class ID for point. The corresponding standard deviations are defined in [gcp-weight-classes]
- **SKIP**: this column is to be skipped and ignored

Example:
`columns= ID E N H WC`

[gcp-weight-classes]*

Note

The section is mandatory if section [ground-control-points] is being introduced.

The values in this section are normally estimations on how accurate the GPS measurements of the ground control points are. The following keywords are possible in this section:

units = *object-unit*

The units can be any one of the units defined by the European Petroleum Survey Group (EPSG) and listed in Appendix 1, and they relate to the output object coordinate system defined in section [rapidstation-block]. The default value is metre.

columns = *description-of-the-columns*

"columns" keyword describes the contents of the tabular data *either* at the end of this section *or* in an external file. The tags should be listed in the same order they appear. The allowed column tags are:

- **ID**: unique string or number identification of the weight class.
- **S_E**: standard deviation of the easting coordinates.
- **S_N**: standard deviation of the northing coordinates.
- **S_EN**: standard deviation of the easting and northing coordinates.
- **S_H**: standard deviation of the height coordinates.
- **S_X**: standard deviation of the X coordinates.
- **S_Y**: standard deviation of the Y coordinates.
- **S_XY**: standard deviation of the X and Y coordinates.
- **S_Z**: standard deviation of the Z coordinates.
- **SKIP**: this column is to be skipped and ignored

Example:

```
columns= ID S_EN S_H
pos1 0.02 0.2
```

[adjusted-points]

The values in this section are normally output from bundle block adjustment. In case of a close-range photogrammetric block this section will refer to X Y and Z co-ordinates, else E(asting), N(orthing) and H(eight) are being used. The following keywords are possible in this section:

coordinate-system = *horizontal [vertical]**

Currently only the horizontal coordinate system is used and thus the vertical part can be left out. The value should be the same as corresponding value in section [rapidstation-block] referring to bundle block adjustment. The coordinate system must be one of the ones defined in csystems.ini. See separate manual describing csystems.ini.

units = *horizontal-unit [vertical-unit]*

The units can be any one of the units defined by the European Petroleum Survey Group (EPSG) and listed in Appendix 1. If, e.g., the coordinate system is WGS84 the normal horizontal unit would be degrees. The attitude-unit is needed for IMU readings. The default values of the three units are: metre and metre.

Example:

```
units= degree metre
```

columns = *description-of-the-columns*

"columns" keyword describes the contents of the tabular data *either* at the end of this section *or* in an external file. The tags should be listed in the same order they appear. Use *either* triplet X/Y/Z, E/N/H *or* LAT/LON/ALT. X,Y,Z is used in close range photogrammetry only. The allowed column tags are:

- **ID**: unique string or number identification of the point.
- **TYPE**: type of the point. Either M for manually measured point, A for automatically measured point or C for ground control point
- **TYPEID**: type and ID in the same string. For instance M00101, A12343 or C00004.
- **E**: easting of the point
- **N**: northing of the point
- **H**: height of the point
- **X**: X-coordinate of the point
- **Y**: Y-coordinate of the point
- **Z**: Z-coordinate of the point
- **SKIP**: this column is to be skipped and ignored

Example:

```
columns= ID TYPE E N H
```

[point-photo-observations]

The values in this section are normally coming from the bundle block adjustment. As an exception to all the other sections this one might have two different types of columns. If both of them are used then also the columns2-tag must be specified. The following keywords are possible in this section:

units = *image-unit*

The default unit is rawpixel and is almost always used with digital images. Data from analogue images might need units like i_centimetre or i_millimetre.

columns = *description-of-the-columns*

"columns" keyword describes the contents of the tabular data *either* at the end of this section *or* in an external file. The tags should be listed in the same order they appear. The allowed column tags are:

- **ID**: unique string or number identification of the point.
- **TYPE**: type of the point. Either M for manually measured point, A for automatically measured point or C for ground control point

- **TYPEID**: type and ID in the same string. For instance M00101, A12343 or C00004.
- **FLIGHTLINE**: the number of the flight line or flight line containing the current image. Normally the flight line number changes when the aircraft turns back and flies the next flight line of the block. In a normal photogrammetric block the flight lines should have some side overlap.
- **PHOTO**: the number of the image or frame within the flight line. This number can, e.g., start from 1 at the beginning of each flight line but it can also be a sequential numbering for all images in the block.
- **FLIGHTLINEPHOTO**: another way of expressing the flight line and photo number in one word of type LXXXFYYYY where XXX is the flight line number and YYYY the photo number. Either FLIGHTLINE & PHOTO or FLIGHTLINEPHOTO should be used, not both.
- **COL**: column coordinate of the point
- **ROW**: row coordinate of the point
- **SKIP**: this column is to be skipped and ignored

Example:

```
columns= TYPE ID FLIGHTLINE PHOTO COL ROW

M 1 2 4 123.45 432.11
```

columns2-tag = *column-type-separator*

With this keyword it is possible to separate **columns2** data from **columns** data in cases where image identification data is interleaved with point measurement data. When this tag is found at the beginning of the line the rest of the line is interpreted with **columns2**, else **columns** is assumed.

Example:

```
columns2-tag= P
```

columns2 = *description-of-the-columns*

Using this tag the contents of the tabular data at the end of this section or in an external file is described. The tags should be listed in the same order they appear in the table or in the external file. The allowed column tags are:

- **FLIGHTLINE**: the number of the flight line or flight line containing the current image. Normally the s flight line number changes when the aircraft turns back and flies the next flight line of the block.
- **PHOTO**: the number of the image or frame within the flight line. This number can, e.g., start from 1 at the beginning of each flight line but it can also be a sequential numbering for all images in the block.
- **FLIGHTLINEPHOTO**: another way of expressing the flight line and photo number in one word of type LXXXFYYYY where XXX is the flight line number and YYYY the photo number. Either FLIGHTLINE & PHOTO or FLIGHTLINEPHOTO should be used, not both.
- **SKIP**: this column is to be skipped and ignored

Example:

```
columns= TYPE ID COL ROW
columns2-tag= P
```

```
columns2= FLIGHTLINE PHOTO
P 1 1
M 1 123.45 432.11
C 1 543.23 5566.77
P 1 2 # next image
C 1 1543.23 566.77
A 1233 4432.22 4422.12
A 1234 4132.22 4122.12
```

Examples

Case : Data import to RapidStation

The following is an example of presenting import data for RapidStation using external files. There are three input files, “uav_log1.txt” & “uav_log2.txt” and “gcp.txt”. The “uav_log1.txt” & “uav_log2.txt” files contain trajectory data and image file name and, “gcp.txt” contains ground control point data. There’s no camera calibration data.

The following example of an RSB file is commented to assist keeping track on the section logic. Sections with darker background colour are optional, the purpose being to demonstrate the possibility to introduce a-priori (estimated) standard deviation values for the to-be-imported dataset. These would be needed mainly in bundle block adjustments of RapidStation but not needed in, e.g., RapidTerrain

.RSB file:

```
[rapidstation-block]
file-format-version=        1
created=                    Oct 31 01:28:13.00 2012
block-name=                 My_area
coordinate-system=          WGS84-UTM/SUTM3  # ---- according to PIEneering's
                                             #      csystem.ini database definitions
units=                      metre degree     # ---- object, angular units set for block
flights= 3 5                                 # ---- links to [flight-1] & [flight-2]

[flight-3]                                   # ---- "3" from the 1st value of keyword "flights"
mean-terrain-height= 850                     # ---- needed for approximate image scaling
platform= my-uav                             # ---- link to [platform-my-uav]
image-paths= ..\..\Flight1                   # ---- image file location set
columns= FLIGHTLINE PHOTO IMAGEFILE          # ---- instructions to read block formation
external-file= uav log1.txt                  # ---- directive to read data from external file

[flight-5]                                   # ---- "5" from the 2nd value of keyword "flights"

mean-terrain-height= 900
platform= my-uav
image-paths= ..\..\Flight2
columns= FLIGHTLINE PHOTO IMAGEFILE
external-file= uav_log2.txt

[platform-my-uav]
cameras= nx200                               # ---- link to [camera-nx200]
camera-rotation= 0                           # ---- essential, camera orientation in aircraft

[camera-nx200]
camera-body= Samsung NX200                   # ---- just for information only
lens= 21mm                                   # ---- just for information only
channels= 1                                  # ---- link to [camera-nx200-channel-1]

[camera-nx200-channel-1]                     # ---- single channel "calibration" assumed
focal-length-mm=      21                     # ---- essential
sensor-width-pix-mm=  5472 23.5              # ---- essential, CCD/CMOS width in pixels and mm's
sensor-height-pix-mm= 3648 15.7

[trajectory]
coordinate-system= WGS84
units= degree metre degree                   # ---- horizontal vertical attitude units set
altitudes-from-ground-level= yes             # ---- otherwise from sea level
```

```
common-position-weight-class= p1    # ---- common setting for GPS positions, link to
                                    #      [position-weight-classes]
common-attitude-weight-class= a1    # ---- common setting for IMU data, link to
                                    #      [attitude-weight-classes]
read-from-exif= DATETIME            # ---- directive to read time stamps from image
                                    #      header

columns= FLIGHTLINE PHOTO SKIP LAT LON ALT ROLL PITCH YAW # ---- skip image file names
external-file= uav log1.txt uav log2.txt                  # ---- directive to read data
                                                          #      from 2 external files
[position-weight-classes]
units= metre
columns= ID S_E S_N S_H
p1   5  5  5                        # ---- a-piori approximation set 5 metres for XYZ

[attitude-weight-classes]
units= degree
columns= ID S ROLL S PITCH S YAW
a1  5 5 50                          # ---- a-piori approximation set 5 degrees for roll
                                    #      & pitch, 50 degrees for YAW
[ground-control-points]
coordinate-system= WGS84            # ---- GCP coordinate system set
units= degminsecondhemi metre       # ---- horizontal vertical units set
columns= ID SKIP LAT4 LON4 ALT WC   # ---- skip TYPE during execution, WC value is link
                                    #      to row ID in section [gcp-weight-classes]
external-file= gcp.txt              # ---- directive to read data from external file

[gcp-weight-classes]
columns= ID S E S N S H
1 0.05 0.05 0.10                    # ---- ID field is a link to WC value in section
2 0.09 0.09 0.15                    #      [ground-control-points]/keyword "columns"
3 0.25 0.25 0.25
```

external file "uav_log1.txt":

# Flightline	Photo	Filename	Latitude	Longitude	Height	Roll	Pitch	Heading
1	1	08180002.JPG	-21.97069931	5.58890915	245.28	-0.582	-2.802	162.246
1	2	08180003.JPG	-21.97115707	5.58902550	245.69	7.229	-0.945	164.476
1	3	08180004.JPG	-21.97166061	5.58908844	247.48	-2.461	-3.604	169.464
1	4	08180005.JPG	-21.97213364	5.58914566	246.93	-1.846	-4.164	166.619
1	5	08180006.JPG	-21.97264671	5.58923435	245.83	-1.505	-2.263	163.455
1	6	08180007.JPG	-21.97309875	5.58934498	246.79	0.154	-2.878	160.697
1	7	08180008.JPG	-21.97354126	5.58946610	246.52	0.209	-3.625	160.280
1	8	08180009.JPG	-21.97404099	5.58958530	246.38	-0.385	-3.461	162.246
1	9	08180010.JPG	-21.97452927	5.58969975	245.97	-1.011	-2.747	161.290
1	10	08180011.JPG	-21.97497177	5.58979797	245.28	-2.780	-0.352	162.773
1	11	08180012.JPG	-21.97545052	5.58990479	245.97	-2.417	-2.944	162.114
1	12	08180013.JPG	-21.97593308	5.59002781	245.15	-0.901	-0.615	161.082
1	13	08180014.JPG	-21.97644615	5.59015656	245.28	0.549	-2.549	161.741
1	14	08180015.JPG	-21.97693062	5.59027386	244.60	1.890	-1.033	161.005
1	15	08180016.JPG	-21.97741508	5.59038353	244.18	-1.439	-0.033	163.345
2	1	08180043.JPG	-21.98870850	5.59840012	244.05	-12.360	-1.637	1.241
2	2	08180044.JPG	-21.98824310	5.59827900	245.28	1.505	-0.879	350.925
2	3	08180045.JPG	-21.98778534	5.59815121	245.42	2.186	-2.758	353.991
2	4	08180046.JPG	-21.98731995	5.59805489	245.15	-1.769	-0.176	357.045
2	5	08180047.JPG	-21.98681641	5.59795475	245.42	-0.308	-2.054	355.902
2	6	08180048.JPG	-21.98635101	5.59785175	245.01	-0.308	-0.286	355.968
2	7	08180049.JPG	-21.98589134	5.59774590	245.01	-1.055	-2.043	355.694
2	8	08180050.JPG	-21.98538780	5.59762478	245.56	0.231	-0.703	354.100
2	9	08180051.JPG	-21.98490143	5.59750843	246.79	0.736	-4.285	354.760
2	10	08180052.JPG	-21.98445129	5.59740448	246.93	-0.121	-2.593	354.364
2	11	08180053.JPG	-21.98396301	5.59727955	247.07	-0.439	-3.999	353.980
2	12	08180054.JPG	-21.98346329	5.59715176	244.60	0.055	-0.341	354.913
2	13	08180055.JPG	-21.98297691	5.59702873	245.56	1.329	-1.187	354.639
2	14	08180056.JPG	-21.98247910	5.59692097	245.56	2.208	-1.626	356.166
2	15	08180057.JPG	-21.98201942	5.59684658	245.56	-2.351	-1.813	358.967

external file “gcp.txt”:

```
# ID TYPE   LATITUDE               LONGITUDE              HEIGHT  WC
gcp1 circle 21° 58' 31.65423" S    5° 35' 34.09799" E     922.980 2
gcp2 cross  21° 58' 30.52799" S    5° 35' 32.33670" E     922.220 1
gcp3 cross  21° 58' 27.72997" S    5° 35' 33.32839" E     924.188 1
gcp4 circle 21° 58' 27.36155" S    5° 35' 36.64538" E     926.942 2
gcp5 cross  21° 58' 31.03073" S    5° 35' 36.93007" E     925.156 2
gcp6 rock   21° 58' 34.75403" S    5° 35' 34.81333" E     921.518 3
```

Case : Data import to RapidTerrain

The following is an example of presenting import data for Rapidterrain using one RSB file. The purpose is to present a minimum amount of sections. Camera calibration is known.

The following example of an RSB file is commented to assist keeping track on the section logic.

.RSB file:

```
[rapidstation-block]
file-format-version=        1
created=                    Aug 03 17:28:13.00 2012
block-name=                 Example
coordinate-system=          FinnKKJ/KKJ2     # ---- coordinate system of the
                                             #      output files
units=                      metre degree     # ---- object, angular units set for block
flights= 4                                   # ---- one flight, name “4”

[ground-control-points]
coordinate-system= FinnKKJ/KKJ2
units=             metre metre               # ---- horizontal, vertical units
columns=           ID E N H
1001 378631.9105 6676426.4581 29.5690
1002 378640.1249 6676575.7178 22.3300
1003 378924.3634 6676402.8376 23.1660
1005 379205.8186 6676452.0335 19.6590

[platform-uav1]
cameras= ricoh                      # ---- link to [camera-ricoh]
antenna-offset= 0 0 0
boresight-misalignment= 0 0 0
camera-rotation= 0

[camera-ricoh]
calibrated=    Sep 30 17:28:13.00 2012
camera-body=   Ricoh/GR Digital IV (2011)/CRN097
lens=          Built-in
owner=         Some Company
trigger-delay= 0.0000
channels=      1                    # ---- link to [camera-ricoh-channel-1]

[camera-ricoh-channel-1]            # ---- single channel calibration parameters set
focal-length-pix=            2969.392908991950200
principal-point-x-pix=       1824.782014813620700
principal-point-y-pix=       1302.854313979510400
affinity=                   -0.105057592661175900
radial-k1=                  -6.520972112153175200
radial-k2=                   0.666474302211251920
radial-k3=                  -0.002191664796303768
tangential-t1=              -0.063299677138823673
tangential-t2=              -0.671905493234987720
```

```
un-orthogonality=           -0.170016826188293530
sensor-width-pix-mm=         3648    7.4900
sensor-height-pix-mm=        2736    5.5200

[flight-4]
mean-terrain-height= 50             # ---- essential, as section [adjusted-points] is
                                    #      not included in this example
platform= uav1                      # ---- link to aircraft & camera used
image-paths= ..\..\flight4          # ---- image file location set
columns= O EXCLUDE FLIGHTLINE PHOTO IMAGEFILE O ATTRIBUTES # ---- O EXCLUDE reserved to
    1     1 R0048643.JPG                                  #      introduce field for
    1     2 R0048644.JPG                                  #      commented-out images
*   1     3 R0048645.JPG
    1     4 R0048646.JPG
    1     5 R0048647.JPG water
    1     6 R0048648.JPG water
    1     7 R0048649.JPG
    1     8 R0048650.JPG
*   1     9 R0048651.JPG
    2     1 R0048668.JPG
    2     2 R0048669.JPG
    2     3 R0048670.JPG blurred
    2     4 R0048671.JPG
    2     5 R0048672.JPG

[exterior-orientation]
coordinate-system=      FinnKKJ/KKJ2    # ---- coordinate system of the
                                        #      output files
units= metre gon
columns= FLIGHTLINE PHOTO E N H OMEGA PHI KAPPA O_APPROX
 1  1 379391.464 6677178.928  214.331  -4.3568   7.4237   88.1345
 1  2 379357.398 6677183.679  212.260   4.6842   6.7356   95.9661
 1  3 379318.659 6677187.389  212.012   1.0735   7.1065   98.7942
 1  4 379284.770 6677189.678  212.002   0.5163   7.1140   97.2165
 1  5 379252.413 6677191.771  273.499  -1.9857   3.2270   86.4995 *
 1  6 379219.397 6677193.456  212.000   5.8599  -2.0437   87.9876 *
 1  7 379185.960 6677193.622  205.594   4.5229   6.6902  114.0218
 1  8 379150.649 6677192.548  205.039  -5.0542   9.4725  117.5721
 1  9 379112.132 6677192.677  206.036  -9.5892   9.4014  111.9423
 2  1 378592.541 6677145.320  201.230  -0.0794  -9.1882  297.1800
 2  2 378624.952 6677149.189  202.119  -2.6384 -10.8644  296.3641
 2  3 378655.493 6677152.081  203.210   2.9371 -10.7713  294.5908
 2  4 378692.679 6677155.296  203.372   1.2643  -7.6925  291.8206
 2  5 378726.915 6677156.322  203.834  -0.7476  -8.9476  289.9204
```

Miscellaneous sample RSB sections

Example of adjusted points section:

```
[adjusted-points]
coordinate-system=          FinnKKJ/KKJ2
units= metre
columns= TYPEID E N H
C0001001 378631.866    6676426.485   29.588
C0001002 378640.080    6676575.628   22.346
C0001003 378924.299    6676402.896   23.105
M0000001 378848.163    6676610.731   24.776
M0000002 378878.014    6676576.164   24.871
M0000003 378584.149    6676686.854   21.866
M0000004 378574.301    6676622.394   22.492
A0000001 378480.134    6677311.004   19.759
A0000002 378489.711    6677311.582   18.824
A0000003 378495.723    6677311.936   18.480
A0000004 378500.750    6677311.923   18.870
A0000005 378540.944    6677317.254   18.718
```

Example of adjusted photo observations section:

```
[point-photo-observations]
columns= FLIGHTLINE PHOTO TYPE ID COL ROW
 1 1 C   1011   928.2   354.6
 1 1 A    453  3588.3   501.6
 1 1 A    454  3620.4   582.1
 1 1 A    455  3631.1   825.3
 1 1 A    607  3627.1    72.3
 1 1 A    612  3547.0   181.8
 1 2 C   1011   534.2   624.9
 1 2 A    108  3555.6   651.9
 1 2 A    110  3522.2   693.3
 1 2 A    111  3552.3   788.0
 1 2 A    112  3537.4   810.5
 1 2 A    113  3461.8   693.0
 1 2 A    115  3423.8   850.0
 1 2 A    117  3378.7   836.1
 1 3 C   1011   686.1  1130.4
 1 3 A    143  3623.8   681.9
 1 3 A    147  3573.0   679.8
 1 3 A    148  3575.2   851.8
```

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Appendix 1 : European Petroleum Survey Group (EPSG) units

RSB_NAME	UNIT_OF_MEAS_NAME	UNIT_OF_MEAS_TYPE	FACTOR_B	REMARKS
metre	metre	length	1.0	Also known as International metre. SI standard unit.
foot	foot	length	0.3048	
usfoot	US survey foot	length	12.0	Used in USA.
clarcefoot	Clarke's foot	length	0.304797265	Assumes Clarke's 1865 ratio of 1 British foot = 0.304797265 French legal metres applies to the international metre. Used in older Australian, southern African & British West Indian mapping.
fathom	fathom	length	1.8288	= 6 feet.
nauticalmile	nautical mile	length	1852.0	
germanmetre	German legal metre	length	1.0000135965	Used in Namibia.
uschain	US survey chain	length	792.0	Used in USA primarily for public lands cadastral work.
uslink	US survey link	length	7.92	Used in USA primarily for public lands cadastral work.
usmile	US survey mile	length	63360.0	Used in USA primarily for public lands cadastral work.
km	kilometre	length	1000.0	
clarceyard	Clarke's yard	length	0.914391795	=3 Clarke's feet. Assumes Clarke's 1865 ratio of 1 British foot = 0.304797265 French legal metres applies to the international metre. Used in older Australian, southern African & British West Indian mapping.
clarcechain	Clarke's chain	length	20.11661949	=22 Clarke's yards. Assumes Clarke's 1865 ratio of 1 British foot = 0.304797265 French legal metres applies to the international metre. Used in older Australian, southern African & British West Indian mapping.
clarcelink	Clarke's link	length	0.2011661949	=1/100 Clarke's chain. Assumes Clarke's 1865 ratio of 1 British foot = 0.304797265 French legal metres applies to the international metre. Used in older Australian, southern African & British West Indian mapping.
britishyard	British yard (Sears 1922)	length	36.0	Uses Sear's 1922 British yard-metre ratio as given by Bomford as 39.370147 inches per metre. Used in East Malaysian and older New Zealand mapping.
britishfoot	British foot (Sears 1922)	length	12.0	Uses Sear's 1922 British yard-metre ratio as given by Bomford as 39.370147 inches per metre. Used in East Malaysian and older New Zealand mapping.

RSB_NAME	UNIT_OF_MEAS_NAME	UNIT_OF_MEAS_TYPE	FACTOR_B	REMARKS
britishchain	British chain (Sears 1922)	length	792.0	Uses Sear's 1922 British yard-metre ratio as given by Bomford as 39.370147 inches per metre. Used in East Malaysian and older New Zealand mapping.
britishlink	British link (Sears 1922)	length	7.92	Uses Sear's 1922 British yard-metre ratio as given by Bomford as 39.370147 inches per metre. Used in East Malaysian and older New Zealand mapping.
britishyard1895a	British yard (Benoit 1895 A)	length	0.9143992	Uses Benoit's 1895 British yard-metre ratio as given by Clark as 0.9144992 metres per yard. Used for deriving metric size of ellipsoid in Palestine.
britishfoot1895a	British foot (Benoit 1895 A)	length	0.9143992	Uses Benoit's 1895 British yard-metre ratio as given by Clark as 0.9144992 metres per yard. Used for deriving metric size of ellipsoid in Palestine.
britishchain1895a	British chain (Benoit 1895 A)	length	20.1167824	Uses Benoit's 1895 British yard-metre ratio as given by Clark as 0.9144992 metres per yard. Used for deriving metric size of ellipsoid in Palestine.
britishlink1895a	British link (Benoit 1895 A)	length	0.201167824	Uses Benoit's 1895 British yard-metre ratio as given by Clark as 0.9144992 metres per yard. Used for deriving metric size of ellipsoid in Palestine.
britishyard1895b	British yard (Benoit 1895 B)	length	36.0	G. Bomford \Geodesy\"
britishfoot1895b	British foot (Benoit 1895 B)	length	12.0	Uses Benoit's 1895 British yard-metre ratio as given by Bomford as 39.370113 inches per metre. Used in West Malaysian mapping.
britishchain1895b	British chain (Benoit 1895 B)	length	792.0	Uses Benoit's 1895 British yard-metre ratio as given by Bomford as 39.370113 inches per metre. Used in West Malaysian mapping.
britishlink1895b	British link (Benoit 1895 B)	length	7.92	Uses Benoit's 1895 British yard-metre ratio as given by Bomford as 39.370113 inches per metre. Used in West Malaysian mapping.
britishfoot1865	British foot (1865)	length	0.9144025	Uses Clark's estimate of 1853-1865 British foot-metre ratio of 0.9144025 metres per yard. Used in 1962 and 1975 estimates of Indian foot.
indianfoot	Indian foot	length	12.0	Indian Foot = 0.99999566 British feet (A.R.Clarke 1865). British yard (= 3 British feet) taken to be J.S.Clark's 1865 value of 0.9144025 metres.

RSB_NAME	UNIT_OF_MEAS_NAME	UNIT_OF_MEAS_TYPE	FACTOR_B	REMARKS
indianfoot37	Indian foot (1937)	length	0.30479841	Indian Foot = 0.99999566 British feet (A.R.Clarke 1865). British foot taken to be 1895 Benoit value of 12/39.370113m. Rounded to 8 decimal places as 0.30479841. Used from Bangladesh to Vietnam. Previously used in India and Pakistan but superseded.
indianfoot62	Indian foot (1962)	length	0.3047996	Indian Foot = 0.99999566 British feet (A.R.Clarke 1865). British yard (3 feet) taken to be J.S. Clark's 1865 value of 0.9144025m. Rounded to 8 significant figures with a small error as 1 Ind ft=0.3048996m. Used in Pakistan since metrication.
indianfoot75	Indian foot (1975)	length	0.3047995	Indian Foot = 0.99999566 British feet (A.R.Clarke 1865). British yard (3 feet) taken to be J.S. Clark's 1865 value of 0.9144025m. Rounded to 8 significant figures as 1 Ind ft=0.3048995m. Used in India since metrication.
indianyard	Indian yard	length	36.0	Indian Foot = 0.99999566 British feet (A.R.Clarke 1865). British yard (= 3 British feet) taken to be J.S.Clark's 1865 value of 0.9144025 metres.
indianyard37	Indian yard (1937)	length	0.91439523	Indian Foot = 0.99999566 British feet (A.R.Clarke 1865). British foot taken to be 1895 Benoit value of 12/39.370113m. Rounded to 8 decimal places as 0.30479841. Used from Bangladesh to Vietnam. Previously used in India and Pakistan but superseded.
indianyard62	Indian yard (1962)	length	0.9143988	Indian Foot = 0.99999566 British feet (A.R.Clarke 1865). British yard (3 feet) taken to be J.S. Clark's 1865 value of 0.9144025m. Rounded to 8 significant figures with a small error as 1 Ind ft=0.3048996m. Used in Pakistan since metrication.
indianyard75	Indian yard (1975)	length	0.9143985	Indian Foot = 0.99999566 British feet (A.R.Clarke 1865). British yard (3 feet) taken to be J.S. Clark's 1865 value of 0.9144025m. Rounded to 8 significant figures as 1 Ind ft=0.3048995m. Used in India since metrication.
statutemile	Statute mile	length	1609.344	=5280 feet
goldcoastfoot	Gold Coast foot	length	6378300.0	Used in Ghana and some adjacent parts of British west Africa prior to metrication, except for the metrication of projection defining parameters when British foot (Sears 1922) used.

RSB_NAME	UNIT_OF_MEAS_NAME	UNIT_OF_MEAS_TYPE	FACTOR_B	REMARKS
britishfoot1936	British foot (1936)	length	0.3048007491	For the 1936 retriangulation OSGB defines the relationship of feet of 1796 to the International metre through log(1.48401603) exactly [=0.3048007491...]. Also used for metric conversions in Ireland.
radian	radian	angle	1.0	SI standard unit.
degree	degree	angle	3.14159265358979	= pi/180 radians
arcminute	arc-minute	angle	3.14159265358979	1/60th degree = ((pi/180) / 60) radians
arcsecond	arc-second	angle	3.14159265358979	1/60th arc-minute = ((pi/180) / 3600) radians
grad	grad	angle	3.14159265358979	=pi/200 radians.
gon	gon	angle	3.14159265358979	=pi/200 radians
degminsecond	degree minute second	angle		Degree representation. Format: signed degrees (integer) - arc-minutes (integer) - arc-seconds (real, any precision). Different symbol sets are in use as field separators, for example º ' \.
degminsecondhemi	degree minute second hemisphere	angle		Degree representation. Format: degrees (integer) - arc-minutes (integer) - arc-seconds (real) - hemisphere abbreviation (single character N S E or W). Different symbol sets are in use as field separators for example º ' \.
microradian	microradian	angle	1.0	rad * 10E-6
sexadesimaldms	sexagesimal DMS	angle		Pseudo unit format: signed degrees - period - minutes (two digits) - integer seconds (two digits) - fraction of seconds (any precision). Must include leading zero in minutes and seconds and exclude decimal point for seconds. Convert to deg using formula.
sexadesimaldm	sexagesimal DM	angle		Pseudo unit. Format: sign - degrees - decimal point - integer minutes (two digits) - fraction of minutes (any precision). Must include leading zero in integer minutes. Must exclude decimal point for minutes. Convert to deg using algorithm.
centesimalminute	centesimal minute	angle	3.14159265358979	1/100 of a grad and gon = ((pi/200) / 100) radians
centesimalsecond	centesimal second	angle	3.14159265358979	1/100 of a centesimal minute or 1/10,000th of a grad and gon = ((pi/200) / 10000) radians

RSB_NAME	UNIT_OF_MEAS_NAME	UNIT_OF_MEAS_TYPE	FACTOR_B	REMARKS
mil6400	mil_6400	angle	3.14159265358979	Angle subtended by 1/6400 part of a circle. Approximates to 1/1000th radian. Note that other approximations (notably 1/6300 circle and 1/6000 circle) also exist.
degmin	degree minute	angle		Degree representation. Format: signed degrees (integer) - arc-minutes (real, any precision). Different symbol sets are in use as field separators, for example º '. Convert to degrees using algorithm.
deghemi	degree hemisphere	angle		Degree representation. Format: degrees (real, any precision) - hemisphere abbreviation (single character N S E or W). Convert to degrees using algorithm.
hemideg	hemisphere degree	angle		Degree representation. Format: hemisphere abbreviation (single character N S E or W) - degrees (real, any precision). Convert to degrees using algorithm.
degminhemi	degree minute hemisphere	angle		Degree representation. Format: degrees (integer) - arc-minutes (real, any precision) - hemisphere abbreviation (single character N S E or W). Different symbol sets are in use as field separators, for example º '. Convert to degrees using algorithm.
hemidegmin	hemisphere degree minute	angle		Degree representation. Format: hemisphere abbreviation (single character N S E or W) - degrees (integer) - arc-minutes (real, any precision). Different symbol sets are in use as field separators, for example º '. Convert to degrees using algorithm.
hemidegminsec	hemisphere degree minute second	angle		Degree representation. Format: hemisphere abbreviation (single character N S E or W) - degrees (integer) - arc-minutes (integer) - arc-seconds (real). Different symbol sets are in use as field separators for example º ' \.
sexadesimaldms_s	sexagesimal DMS.s	angle		Pseudo unit. Format: signed degrees - minutes (two digits) - seconds (real, any precision). Must include leading zero in minutes and seconds where value is under 10 and include decimal separator for seconds. Convert to degree using algorithm.

RSB_NAME	UNIT_OF_MEAS_NAME	UNIT_OF_MEAS_TYPE	FACTOR_B	REMARKS
sexadesimaldms_sss	degree (supplier to define representation)	angle	3.14159265358979	= pi/180 radians. The degree representation (e.g. decimal, DMSH, etc.) must be clarified by suppliers of data associated with this code.
binw_us330	Bin width 330 US survey feet	length	3960.0	
binw_us165	Bin width 165 US survey feet	length	1980.0	
binw_us825	Bin width 82.5 US survey feet	length	990.0	
binw_us375	Bin width 37.5 metres	length	37.5	
binw_us25m	Bin width 25 metres	length	25.0	
binw_us125m	Bin width 12.5 metres	length	12.5	
binw_us0625m	Bin width 6.25 metres	length	6.25	
binw_us03125m	Bin width 3.125 metres	length	3.125	
decimetre	decimetre	length	0.1	
centimetre	centimetre	length	0.01	
millimetre	millimetre	length	0.001	
micrometre	micrometre	length	0.0001	
nanometre	nanometre	length	0.000000001	
inch	inch	length	0.0254	